

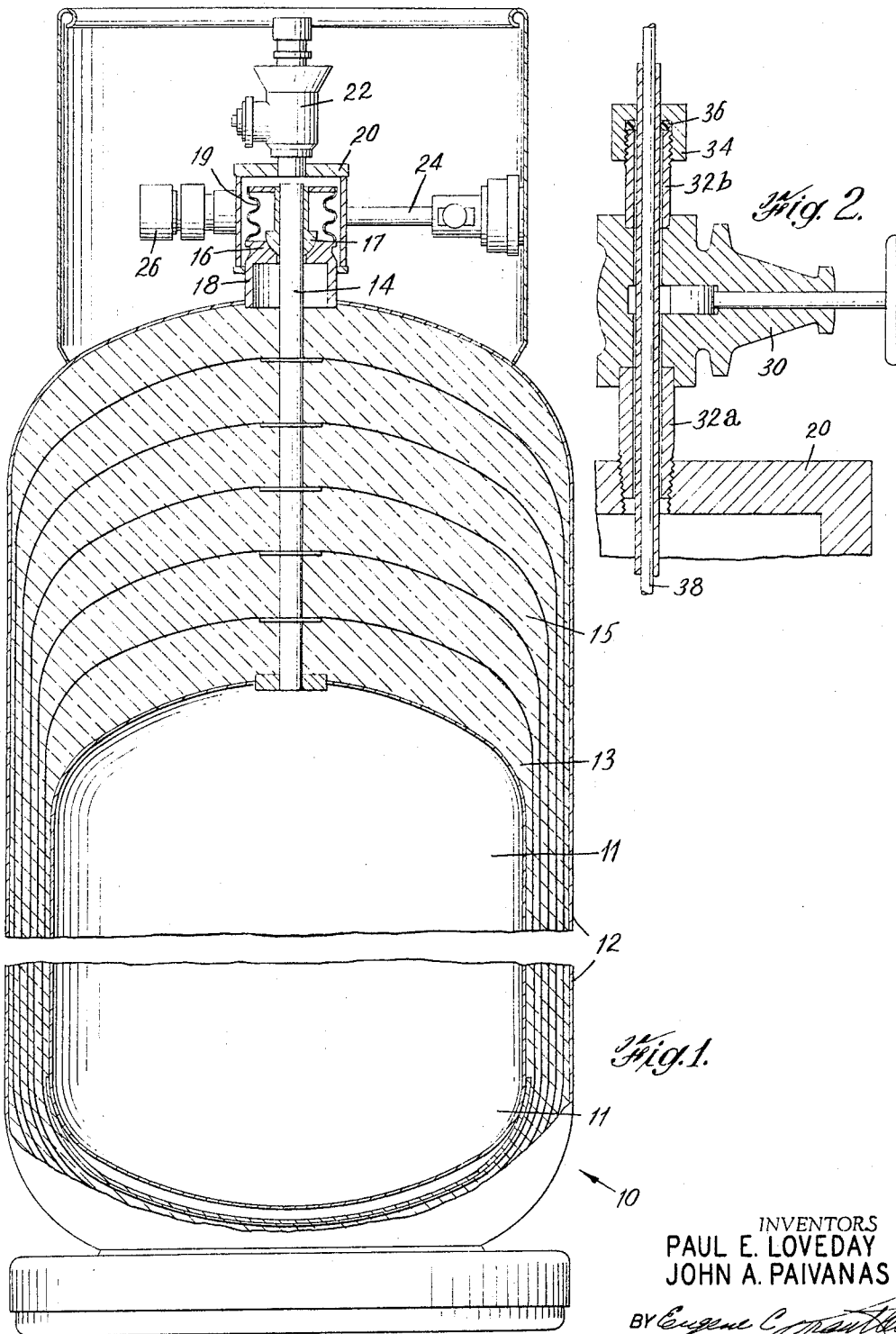
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DOUBLE-WALLED INSULATED CONTAINER

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DOUBLE-WALLED INSULATED CONTAINER

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This invention relates to double-walled containers having compressible insulation between the walls, and particularly to cryogenic containers for storing low boiling liquefied gases as, for example, liquid helium, neon and hydrogen.

The problem of transporting and handling low boiling liquefied gases such as helium, neon and hydrogen in liquid form is much more severe than that of transporting liquid oxygen and nitrogen. For example, the heat required to vaporize 1 liter of liquid helium is approximately 3 B.t.u., or about 1 percent of the heat required to vaporize 1 liter of liquid oxygen. Consequently, great care must be taken to minimize the amount of heat that passes through the container into the stored liquid. Unless a highly efficient insulating system is provided, a substantial portion of the stored liquid will evaporate due to atmospheric heat inleak. This in turn results in a pressure rise which must be relieved by venting and consequent loss of product. On the other hand, the commercial usage of low boiling liquefied gases has expanded in recent years to the point where large quantities are required at locations remote from the point of liquefaction. This means that the containers must be of rugged construction, readily portable and extremely well insulated.

The prior art has proposed many insulated containers for storing and transporting low boiling liquefied gases. One common type container is comprised of an inner vessel for holding the liquefied gas and an outer shell surrounding the inner vessel and spaced therefrom so as to form an intervening vacuum space. A compressible composite multi-layered insulation comprised of a low conductive component and a radiant heat barrier component is disposed within the vacuum space with the layers disposed generally parallel to the container walls and normal to the flow of heat. A fluid conduit is provided between the inner vessel and the outer shell for transporting the stored gas from the container.

In some containers the fluid conduit also serves to vertically support the inner vessel while the compressible insulation in the vacuum space is utilized to provide lateral support for the inner vessel. In other container constructions the fluid conduit does not serve as a support for the inner vessel but, because of the need for sealing the inner vessel from the vacuum space and for sealing the vacuum space from the ambient atmosphere, such conduit is generally rigidly connected to the inner vessel and the outer shell. In both cases, a severe loading is often placed on the fluid conduit whenever the container is subjected to sudden lateral movement. Often, this sudden load will cause the conduit to kink or buckle unless it has a relatively large wall thickness and a long enough length to deflect without failing. Of course, the effects of side-sway of the inner vessel on the fluid conduit is much more severe when this conduit serves as a vertical support for the inner vessel as well as a fluid conduit.

Unfortunately, the problem is magnified by the fact that the heat inleak to the container through the fluid conduit is a function of its length and wall thickness. Thus the use of a long heavy walled conduit to insure against failures due to sudden deflection loads results in an increase in heat inleak to the container. Moreover, the heat inleak to the container through the fluid conduit represents a sizeable portion of the total heat inleak to

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the container. As an illustration of the effect of just the wall thickness of the fluid conduit upon the overall performance of a given container, the liquid loss from a specific 500 liter liquid helium container having a fluid conduit 15 inches in length and a wall thickness of 0.020 in. was about 3.62 liters per day. Increasing the wall thickness of the conduit to 0.035 in. would result in a liquid loss of about 4.47 liters per day. When the stored liquid is extremely valuable such as liquid helium, the increase in liquid loss due to just a small increase in the wall thickness of the fluid conduit can amount to a loss of many thousands of dollars over the life of the container.

Another important source of heat inleak to a container holding a liquefied gas is from the withdrawal tube which is necessary for filling or withdrawing liquid from the container. In the storage of low boiling gases such as liquid helium, neon and hydrogen, the liquid withdrawal tube is made removable and is inserted through the fluid conduit only whenever a liquid fill or withdrawal is to be made; during the remainder of the time the tube does not contribute heat to the cold liquid. Whenever such a transfer tube is inserted into the container through the fluid conduit, it is necessary to prevent the entry of air into such conduit. If air enters the fluid conduit, it may become plugged with solidified gases having freezing points above that of the stored liquid.

An object of this invention is to provide an improved double walled container having a fluid conduit between its inner vessel and outer shell which is resistant to sudden deflection loads and yet has low heat inleak.

Another object is to reduce evaporation of low boiling liquefied gas stored in such containers for sustained periods.

Yet another object is to provide an improved liquefied gas container having provision for inserting and removing a liquid transfer tube while preventing the entry of air into the container opening.

Further objects and advantages of the invention will be apparent from the following description and drawing.

In the drawings:

FIG. 1 is a longitudinal cross-sectional view of a double walled insulated container constructed according to the present invention.

FIG. 2 is a longitudinal cross-sectional view of part of a preferred container construction suitable for use with the FIG. 1 container.

According to the invention a low boiling liquefied gas container is provided and is comprised of an inner vessel for holding the liquefied gas. An outer shell surrounds the inner vessel and is spaced therefrom so as to form an intervening vacuum space. The container has a compressible insulation in this vacuum space. A fluid conduit is provided between the inner vessel and the outer shell. This conduit preferably serves to support the inner vessel as well as to transport the stored liquid from the container. A pivotal swivel joint is provided and surrounds the fluid conduit adjacent the point where it passes through the top of the outer shell. A flexible gas-tight enclosure surrounds the pivotal swivel joint in order to seal off the insulation space from the inner container pressure or the ambient atmosphere. A protective pressure housing surrounds the flexible gas-tight enclosure and serves to seal off the inner vessel pressure from the pressure of the ambient atmosphere as well as to protect the flexible gas-tight enclosure.

The pivotal swivel joint is preferably comprised of a hollow spherical plug upper portion which is supported upon a mating annular seated surface lower portion. The flexible gas-tight enclosure is preferably a flexible metal bellows.

The compressible insulation in the vacuum space is preferably a multi-layered composite comprised of a low conductive component and a radiant heat barrier component. The low conductive component is preferably a fibrous material composed of many elements of small cross-section dimension having a solid volume not exceeding 10 percent of its gross volume (at least 90 percent voids). The radiation barrier component may consist of a flexible metal foil such as aluminum or copper of less than about 0.0008 inch thick and usually about 0.00025 inch thick. The fibrous material may be in the form of an elastically compressible web or mat of glass fibers. This insulation is described and claimed in U.S. Patent No. 3,009,601 issued November 21, 1961, to L. C. Matsch, the disclosure being incorporated herein to the extent pertinent.

Another suitable composite multi-layered compressible insulation is the metal-coated flexible plastic material described in U.S. Patent No. 3,018,016 issued January 23, 1962, to M. P. Hnilicka, Jr. The metal coating should have a thickness less than about 0.25 micron and yet be sufficiently thick to have an emissivity less than 0.06. The individual layers of metal-coated plastic are preferably permanently deformed, as by crumpling, so as to be free of extensive areas of planar contact. A suggested composite is aluminum-coated polyethylene terephthalate film.

According to another embodiment of the invention a conduit of approximately the same diameter as the fluid conduit is connected to the top of the protective pressure housing in spaced axial alignment with the fluid conduit. An O-ring seal is secured to the opposite end of this conduit by means of a cap having an annular rear surface. A shut-off valve having a straight-through opening is connected in this conduit between the O-ring seal and the protective pressure housing.

Referring now to FIG. 1, a double walled, low boiling liquefied gas container 10 is illustrated. Inner vessel 11 storing the low boiling liquefied gas, e.g. liquid helium, is surrounded by outer shell 12 with vacuum space 13 therebetween. The inner vessel 11 is preferably supported by fluid conduit 14. Disposed within vacuum space 13 is the compressible insulation 15, preferably a multi-layered composite, which also serves to stabilize inner vessel 11 against lateral movement or side-sway. To better enable the container to withstand sudden lateral movement of the inner vessel 11, the upper end of fluid conduit 14 has a pivotal swivel joint 16. This swivel joint is comprised of a hollow spherical plug upper portion 17 and a mating annular seated surface lower portion 18 which supports it. The supporting lower portion 18 in turn is secured to the top of the outer shell 12. To provide a pressure seal, the pivotal swivel joint is enclosed in a flexible metal bellows 19. The inside of the bellows is usually exposed to a vacuum pressure while the outside of the bellows is exposed to the pressure of the fluid in the inner vessel. The bellows 19 is enclosed and protected by pressure housing 20, which has inner vessel pressure external to the bellows. The container may be filled with a low boiling liquefied gas through valve 22 attached to the upper side of pressure housing 20, by means of a liquid transfer tube (not shown). Liquid withdrawal occurs in a similar manner. Gas pressure is withdrawn from inner vessel 11 through connection 24 attached to the side of pressure housing 20. Bursting disc assembly 26 may also be connected to pressure housing 20 if desired.

The FIG. 1 container is capable of withstanding sudden lateral movement of inner vessel 11. The hollow fluid conduit 14 is subjected to predominately tension forces. Any bending force put upon it by a sudden side-sway of inner vessel 11 will be substantially absorbed by movement of the pivotal swivel joint 16. This arrangement permits conduit 14 to be constructed of relatively thin walls having very little heat conduction. This in turn will be a contributing factor in reducing the rate of liquid loss from the container by evaporation due to heat inleak.

To prevent the infiltration of ambient air into the container when charging or withdrawing liquid, the arrangement shown in FIG. 2 is preferred in lieu of valve 22 in FIG. 1 container. As shown in FIG. 2, the apparatus consists of a shut-off valve 30 having a straight-through opening, connected by conduit or nipple 32a to the top of pressure housing 20, and connected by conduit or nipple 32b to a cap 34 in which there is an O-ring seal 36. The rear surface of cap 34 is annular in shape to permit the insertion of a liquid transfer tube 38 therethrough. The conduit 32a is connected to pressure housing 20 in spaced axial alignment with conduit 14.

When the low-boiling liquefied gas, e.g. liquid helium, is to be withdrawn from inner vessel 11, a liquid transfer tube 38 is first inserted through the O-ring seal 36 in cap 34. After having established this initial seal, shut-off valve 30 is opened and tube 38 is inserted through the valve into the container, through fluid conduit 14. The close-fitting O-ring seal prevents air from entering the container during the insertion and withdrawal of tube 38, and thus prevents solidification blockage of conduit 14.

Although preferred embodiments of the invention have been described in detail, it is to be understood that modifications and variations may be made without departing from the spirit and scope of the invention. For example, the filling and withdrawal arrangement shown in FIG. 2 may be used in combination with other containers having a gas tight pressure housing sealing off the pressure of the inner vessel from the ambient atmosphere.

What is claimed is:

1. A low-boiling liquefied gas container comprising an inner vessel for holding the liquefied gas; an outer shell surrounding said inner vessel and spaced therefrom so as to form an intervening vacuum space; a compressible insulation disposed within such space; a fluid conduit between said inner vessel and said outer shell for transporting such liquefied gas from the container; a pivotal swivel joint surrounding said fluid conduit adjacent the point where said conduit passes through the top of said outer shell; and a flexible gas-tight enclosure surrounding said pivotal swivel joint for sealing the insulation space from the ambient atmosphere.

2. A low-boiling liquefied gas container comprising an inner vessel for holding the liquefied gas; an outer shell surrounding said inner vessel and spaced therefrom so as to form an intervening vacuum space; a compressible composite multi-layered insulation comprised of a low conductive component and a radiant heat barrier component disposed within such space; a fluid conduit between said inner vessel and said outer shell for transporting such liquefied gas from the container; said fluid conduit comprising the sole vertical support for said inner vessel; a pivotal swivel joint surrounding said fluid conduit adjacent the point where said conduit passes through the top of said outer shell; a flexible gas-tight enclosure surrounding said pivotal swivel joint for sealing the insulation space from the inner vessel; and a protective pressure housing surrounding said flexible gas-tight enclosure for sealing the inner vessel from the pressure of the ambient atmosphere.

3. A low-boiling liquefied gas container according to claim 2, wherein said pivotal swivel joint is comprised of a hollow spherical plug upper portion which is supported upon a mating annular seated surface lower portion.

4. A low-boiling liquefied gas container according to claim 2, wherein a flexible metal bellows comprises said flexible gas-tight enclosure.

5. A low-boiling liquefied gas container according to claim 2, including a conduit connected to the top of said protective pressure housing in spaced axial alignment with said fluid conduit; means for securing an O-ring seal to the upper end of said conduit, and a shut-off valve having a straight through opening connected in said conduit between said O-ring seal and said protective pressure housing.

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6. A low-boiling liquefied gas container according to claim 5, wherein said means for securing said O-ring seal to said conduit comprises a cap having an annular shaped rear surface.

7. A double-walled low-boiling liquefied gas container comprising an inner vessel for holding the liquefied gas; an outer shell surrounding said inner vessel and spaced therefrom so as to form an intervening vacuum space; a composite multi-layered insulation disposed within such space; a fluid conduit between said inner vessel and said outer shell for transporting such liquefied gas from the container; a protective pressure housing surrounding the upper end of said fluid conduit for sealing said inner vessel from the pressure of the ambient atmosphere; a conduit connected to the top of said pressure housing in spaced axial alignment with said fluid conduit; means for securing an O-ring seal to the opposite end of said conduit; and a shut-off valve having a straight through opening connected in said conduit between said O-ring seal and said protective pressure housing.

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8. A low-boiling liquefied gas container according to claim 7, wherein a cap having an annular shaped rear surface comprises said means for securing said O-ring seal to said conduit.

References Cited by the Examiner

UNITED STATES PATENTS

	354,150	12/1886	Jones	222—464	X
10	1,561,101	11/1925	Mott et al.	220—10	
	2,596,244	5/1952	Jacket	220—15	
	2,767,962	10/1956	Blackburn	220—15	X
	3,097,084	7/1963	Putman	220—14	X
15	3,101,862	8/1963	Matsch	220—14	
	3,133,422	5/1964	Paivanas et al.	220—15	X

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